SCIENCE

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

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SCIENCE:

A Weekly Record of Scientific Progress.

JOHN MICHELS, Editor.

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SATURDAY, MARCH 4, 1882.

JOHN WILLIAM DRAPER, M.D., LL.D.

The death of Dr. John William Draper removes from the circle of American Scientists a man who could be least spared, but the great results of his life of usefulness and devotion to science will, for many years to come, remind us of his familiar presence, and his memory will be cherished wherever the physical sciences are known and appreciated.

Born at St. Helens, near Liverpool, England, on the 5th of May, 1811, he came to this country when 22 years of age and took a medical degree at the University of Pennsylvania, and shortly afterwards he received the appointment of Professor of Chemistry and Physiology in the University of New York, where he afterwards remained until the time of his death.

Prof. JOHN WILLIAM DRAPER,
(Chemist and Historian) Died January 4, aged 70.

Dr. Draper's scientific career may be studied with profit by all engaged in similar investigations, as an example of close application and persistent work, achieving the highest distinction in his own line of research, without any of those appeals to popular sympathy and support, which too many modern physicists are so eager to receive, and regard as elements of success.

For more than 40 years Dr. Draper was quietly engaged in careful experimental researches in physiology and molecular chemistry; these researches covered a very large range of subjects, but were more particularly devoted to a study of the chemical phenomena of light in both the organic and inorganic world, a description of which may be found in his work "*Scientific Memoirs, being Experimental Contributions to a Knowledge of Radiant Energy.*" This volume is described by "*The American Journal of Science,*" in its obituary notice of Dr. Draper as "a noble monument to his memory, made of the results of labors which have greatly advanced the sum of human knowledge."

In the department of spectrum analysis and photography, his original discoveries were of great value. He doubled the number of the recognized fixed lines in the spectrum, described those at the red end, demonstrated that the fixed lines might be photographed, and brought all these discoveries to bear on his investigations into the nature of flame and the conditions of the sun's surface. In conducting the long series of experiments which resulted in so many important discoveries, Dr. Draper drew largely on his private fortune, and it is asserted that no private person in America has expended more money in a purely scientific direction; his generosity kept pace with his scientific attainments, for whatever scientific discoveries he made—and they were very numerous—he freely gave to the world. He never took out a patent for any of his discoveries, nor sought to make them a source of personal profit.

In the "Scientific Memoirs," Dr. Draper claimed to have made "the first photographic portrait from the life," and he further states, "I also obtained the first photograph of the moon;" the other claims in this work to scientific discoveries are most remarkable, as the result of the work of one man's investigations in a single line of research.

In 1875 the American Academy of Arts and Sciences awarded the Rumford medals to Dr. Draper for his "*Researches on Radiant Energy.*"

Of the literary work of Dr. Draper we would speak in detail, for the subject has many attractions; but it appears unnecessary to describe books which are read

universally, and form part of the education of every liberal-minded and intelligent man. Dr. Draper's books show that he was a deep thinker in the department of the philosophy of history and human progress, and that he aimed to exalt the intellectual development of man.

The "*History of the Conflict of Religion and Science*," a work which many readers consider is incorrectly represented by the title, proves how broad and liberal were Dr. Draper's views, and it may surprise many to learn, that such opinions were not considered by him inconsistent with religious belief. The materialists appear to have written and published in vain for him, as we are told in the "*American Journal of Science*," that "it is a satisfaction to affirm that he was a theist and a firm believer in a future state of existence, for which the present is only a preparation."

On the 4th of January last, Dr. Draper peacefully surrendered his life, honored and respected by all nations, for his fame had been diffused throughout the civilized world by reason of the translation of his works into both European and Asiatic languages.

Dr. Draper leaves two daughters and three sons, the latter having already achieved distinction in pursuits kindred to the work of their father. As the work of Herschell was continued by his son, so in Professor Henry Draper we find all the special qualities for maintaining the high prestige of the family name; his recent success in photographing such difficult celestial objects as nebulous matter, and the important discovery of the presence of oxygen in the sun, have placed him in the foremost rank of original scientific workers, and the furthur development of his investigations are anticipated with keen interest by physicists, both in this country and abroad.

VEGETABLE PATHOLOGY.

By T. J. Burrill, Ph. D.

It is not an easy accomplishment to separate physiology from pathology when, instead of dealing with the definitions of words, we attempt to classify the operations taking place within a living object, by placing them in the one or the other category of activities and effects. Indeed there is no well marked and uniformly acceptable line of division. We may speak of one as normal and healthful and the other as abnormal and injurious; but these vary with the standpoint from which our judgment is made, and with the conditions which modify, this way and that, the results.

If these things are true as regards the vital processes of animals, they are much more evidently true concerning those of plants. In the latter, the standards of health and disease are not so well agreed upon; less attention has been given to the life processes and their results; the individuality of the plant has been less recognized, and its own particular good or injury less regarded. If an apple-tree produces for *us* a crop of good sized, highly flavored, richly colored fruit, we do not stop to ask whether these luscious pippins are the results of physiological or pathological operations, judged from the standpoint of the *tree*. If a cabbage has its terminal bud enormously developed so as to be called a head, the monstrosity never calls forth a compassionate word of sympathy as *we* enjoy the crisp and savory production, for a New Year's dinner. The ink with which we preserve our thoughts, flows no less freely because of a peculiar wound in a particular tree by a particular insect, and a most wonderful malformation of the growing tissues in consequence. We have not listened to the masterly disquisition of a learned and betitled oak upon *septicemia* or the curiosities of *traumatic tumors*. We have heard no complaints from suffering, bleeding grape vines; no uneasy groans from plants perishing through the withering effects of blight and mildew.

But the terms physiology and pathology do have a meaning answering to the operations and conditions of health and disease in plants as well as in animals. The grasses of the fields and meadows may flourish in the luxuriance of bountiful supply and perfect adaption, their vital forces being attuned and harmonized into combinations of causes and consequences, all conspiring to the good of the individual and the welfare of the species; or these members of the vegetable kingdom, may, through unfavorable conditions, through privation, through the attack of enemies, become dwarfed or distorted, weak or disproportioned, unfruitful or incapable of growth and self-perpetuation.

Without attempting to give in this place a classification of the diseases of plants, much less a description of the many that are now known and more or less clearly understood as to origin and progress, we proceed to give some account of a few of the more general facts and phenomena connected with our subject.

THE PROCESSES OF PHYSIOLOGY AND PATHOLOGY IN PLANTS ARE SLOW.

Except in the case of violently disturbing causes, like fire, frost, caustic chemicals, etc., disease or death never attacks a plant in the sudden and unheralded manner frequently known in animals. It is true that what has been called "blight," a very indefinite and loosely applied term, is usually supposed to be the work of a day or a night, perhaps of an hour; but the facts have not been known by those who make this supposition. If by "blight" is meant the results of a tornado or even of a sirocco, with which we of Illinois can claim some acquaintance after the last summer's experience—if these are meant, we cannot say that "blight" is not sudden; but the effects of such agencies should be classed as injuries rather than as diseases, There are really no exceptions to the rule that true pathological operations in plants are slow in their progress. The healing of wounds offers us a good illustration, if we examine the process in plants compared with that in animals. If from a healthy, rapidly growing tree, we cut off a limb close to the trunk, making a wound one inch in diameter, a whole year will scarcely suffice for complete healing, while in most animals a clean cut of this kind may be covered with newly produced tissue in a fortnight. We talk about the *circulation* of the sap; but in plants the fluids do not circulate in any proper sense. The slow movement which does take place is at best a process of *soaking*. When water is most rapidly ascending in the stem of a leafy plant to supply the loss by transpiration, one foot per hour is more than is commonly gained; and this is altogether exceptional speed for movements in plants generally. This feeble distribution of the fluids in living vegetation is no doubt one of the reasons for the slow workings of disease. Again the want of sympathetic

action of one part with another, so common in animal bodies, is almost or entirely wanting in plants, due probably to the absence of a well developed nervous system. Nothing is more common than to find a leaf dotted here and there with diseased parts, while the intervening tissues remain active and healthy. No organ suffers because another is affected, unless there is a direct dependence in the way of food supply or other similar reason. Hence diseased action can not be rapidly communicated from part to part. The tree never becomes flushed with fever because some one or more of its members have met with disaster. In order that disease may spread at all, it is necessary that the disease producing agent shall itself spread from its original point of attack.

INHERITANCE, OR CONTINUANCE OF PECULIAR EFFECTS.

The protoplasm of the cells is "the physical basis of life" in plants. From this flows the issues of life. Not only all other material products are secreted by the more or less plastic, often semifluid, substance known by this name, but the peculiar and unexplained products of vitality are due to the same source. Whatever potential difference exists in the seed of a thistle separating it from that of a turnip; in a bit of a twig of a Bartlett pear, used as a scion, from the worthless stock on which it is set; whatever difference there may be between health and disease, considered as a constitutional affectation, resides in this wonderful, ever-present, ever-important constituent of living plants—protoplasm.

There is nothing more wonderful in the phenomena of plant life than the peculiar tenacity with which an impression once made is held by living protoplasm. We may not be able, with all our skill, to introduce or cause a change to take place; but when an effect is produced, the changed cell may by reproduction become tens of thousands of similar cells, all having the same peculiarity of vital potency and power. It is upon this principle that horticulturists depend in the propagation of special varieties of plants by grafting, budding, cuttings, etc. It is because of this mysterious but interesting quality of the "germinal matter" of the tissues of plants that Baldwins among apples, Bartletts among pears, Marechal Niel's among roses, etc., are possible.

Now any deviation from the normal character of the plant by which it is rendered less capable of succeeding in the struggle for existence on its own account, and by its own forces must be considered a disease. Usually our highly prized fruits are produced as abnormal growths, and the trees that produce them are notoriously liable to seriously suffer from enemies and unfavorable surroundings and conditions, which, to their rough, hardy progenitors would have been as the summer shower and the smiling sun.

So the blotched leaves and variously colored foliage of many decorative pets of the garden, are but indications of a protoplasmic impression continuing itself as a disease. When it happens that these disease changes of the plant are beneficial to us, or when they in any way please our fancy, we do not think of them as pathological conditions and effects; but when through the operations of the same law the opposite is true, we quickly enough talk of failure through disease. Our potatoes all go to vines with no tubers, our strawberries blossom profusely but the flowers are "blasted," our sweet corn becomes too big and coarse, our melons lose their sugar, etc. How the impressions originally occur we do not usually know, but that they are made we cannot doubt, nor too clearly see their permanence, if we would study the causes of health and disease, and try to learn how to profit thereby.

Connected with this topic is a most peculiar phenomenon not yet well understood on the botanical side and perhaps not yet adequately studied. Who can explain why it is that a certain and regular abnormal growth takes place on a given plant after the sting of a certain insect forming what is called a gall? Anyone who has seen the leaves of a jack oak ornamented with "oak apples," especially if he has broken them open and examined the complexity and regularity of their structure, can hardly have helped wondering at the peculiar something which could produce in an abnormal, diseased growth so close an imitation of a true and proper fruit. What can be more strange with our knowledge of the constancy of form and character in plant growth generally, than that a tiny wound with the injection perhaps of a minute drop of a special kind of poison by a particular insect, should entirely modify this growth and produce, not a distorted, irregular knot, but an uniform, constant and thoroughly characteristic though abnormal multiplication and shaping of cells, producing thereby an organic structure so peculiar and so uniformly the same that it may be subjected to all the procedures of natural classification and of specific identification! Though the subject has not been studied from the botanist's stand-point, especially in its physiological or pathological bearings as its importance would seem to justify and demand, it is at least questionable whether the microscope would reveal anything tending to explain the marvelous result. The structure is, like other plant tissues, formed of cells which through inherent forces and properties, rather than through external agencies, shape themselves, and by their co-ordinated and united impulses give form and character to the resulting production. It is also here as elsewhere, the living protoplasm that receives and bears the directing impulse. The cell walls passively bend and swell under its silent and incomprehensible, but dominating power. The wonder is increased when we remember that the growth is not a continued reproduction of the same thing, but that certain cells of the new structure are shaped and modified to form the external wall with its various and inter-differentiated layers, others to form the core or nucleus and still others widely differing from any of the former to make up the mediary parts of the gall. What subtle influence, what magic power is it, that thus toys with the vitalized forces and substances of the plant? What invisible barrier turns the usually inflexible current of life from its healthful and appropriate course and converts the onward rush into swelling pools with their own peculiar currents and eddies and waves, and self-controlled depths and boundaries? A gall produced by a plant in obedience to a particular act of an insect is certainly a most remarkable thing, and merits the closest and most profound study. Why should not man be able to effect as great a modification in the growth of a tender plant, as a buzzing insect? If we knew how why should we not gather grapes from thorns and figs from thistles?

But we must not lose sight of the fact that so far as the plant is concerned, a gall is a disease and sometimes a very serious one. If there is anything whatever, in plant pathology to support Dr. Lionel Beale's theory of "disease germs" being the degraded but still living cells of the ordinary tissues, it is this of insect galls. Is it not possible that a careful study of the latter might be of service to the specialist in gaining more and better knowledge of the origin and development of cancer in the human body?

PLANT DISEASES ARE DUE TO SPECIFIC AGENCIES.

There is no more important item of knowledge connected with vegetable pathology than that each disease has its own predisposing cause, or, in other words, that each disease is a specific thing itself, in the same sense and manner as a particular plant belongs to a species bearing relations to, but unlike every other species.

There is no clearer illustration of the truth of the foregoing than in the matter just before us of insect galls. Entomologists have given these structures much attention, and it is found as easy to recognize the gall as a species, as it is the insect that causes the growth. A skillful specialist in this matter will give us the name of the

insect on seeing its domicile, as readily as upon seeing the winged inhabitant itself. Each one of the hundreds of these curious structures differs from every other one, and owes its existence to a different agent from that of any other one. There are a very few possible exceptions to this if we limit the difference in insects to specific distinctions, for it is known that at least one species produces several kinds of galls on the same parts of the same plant, while others make somewhat different galls on different parts of a given plant, as in the case of the devastating *Phylloxera*. But every one knows that the individuals of a species vary much among themselves, so that our rule should be strengthened rather than broken by these apparent exceptions. There are at least one hundred kinds of galls known upon oaks; hence we may say there are one hundred specific agents, each working after its own fashion and producing its own peculiar results.

Much might also be said of diseases of plants caused by insects which do not form galls, illustrating the same thing; but these are passed without remark to save time and room for those more particularly falling under my own observation and the subjects of more personal investigation, viz: those caused by parasitic fungi.

Though having had a very good chance to find out, I do not know of a single flowering plant in our country which is not more or less injuriously affected by one or more fungi, living as parasites on, or in, its substance. Sometimes numerous species dwell on (or in) one host plant; sometime the same parasite preys on many kinds; but very often a particular fungus is found only upon a particular supporting plant. Nearly all of these myriads of thieves are so small that they cannot be seen, certainly are not usually seen by the unaided eye, except as they occur in masses. Many are at times exceedingly destructive, as witness the wholesale rotting of potatoes during certain seasons, while yet in the ground and attached to the stems of the plants; and the dreaded rust of wheat, which apparently cuts off the farmer's returns for a year's labor in a week or a day. We pay less attention to the diseases and death of uncultivated plants, but these, too, suffer as severely. I have observed great areas of thickly springing smart weed (Polygonum Pennsylvanicum and P. hydropiper) destroyed almost as effectually as by fire, by a vegetable parasite (Helmin thosporium) whose corrosive action caused the leaves, long before frost in autumn, and before the maturity of the plant, to shrivel and die, after which the entire plants soon succumbed.

Though these mischief-makers are usually invisible to untrained and unaided eyes, their peculiar effects are ordinarily recognizable at once, by an expert, even without his magnifier. Each has its own characteristic influence upon the host—one causing yellowish spots on the leaves, another a curled and distorted growth, another little cracks on the stems, another swellings like insect galls, etc., etc. A closer examination brings into clearer relief the different injuries or modifications of growth, caused by each different parasite. Each faded spot, each tumid projection, each rupture of the epidermis, each blister and canker, each puncture and corrosion, has its own more or less clearly marked characteristics; and each parasite has, as well, its own pathological influences and effects. The grapevine alone has at least thirty species of parasite fungi peculiar to it and all more or less injurious, while an entire book of some hundred and fifty pages has been filled with generic and specific descriptions of fungi, known to occur on the cultivated vine. (Thümen, Die Pilze des Weinstockes, Wien, 1878.) The list of specific and separate causes of disease in plants thus immeasurably exceeds that known to the wisest practitioner of medicine for man, for the illustration from the grapevine, though a strong example, is not exceptional. Of fungi, as a class, there are many more species growing in Illinois than there are flowering plants, putting the native and introduced together,—at least double as many. Large numbers of these, however, never grow on living plants; they are the scavengers of the vegetable world.

Two questions may now be raised. (1.) Are all these fungous growths really divisible into good specific forms? in other words, can the term species be applied to these various productions in the same sense as it is used for the higher plants and animals? (2.) Do those kinds known to inhabit living plants really cause disease, or are they mere concomitants of pathological conditions, due to other influences?

These questions are continually pressing for answer, founded on careful observation and skillful investigation. The first one has been, and must be, answered unhesitatingly in the affirmative by every botanist who has made, or may make, a special study of the plants. There are curious alternations of generation, as among the lower animals—a given species presenting itself under two, three, or even four forms. There are also deviations from the recognized type, and modifications due to circumstances and conditions; but it is doubtful whether these fluctuations are greater than in the species of higher and better known organisms. It does require, perhaps, keener perceptions to distinguish allied species than among those having greater differentiation of parts, as root and stem and leaf and flower and fruit; but none of these affect the general question. We admit the probability of evolution of species in the world, and should be theoretically disposed to look for greater plasticity in these low forms than in the higher; yet, except in the particulars cited, observation does not apparently support the deduction. I am sure that any botanist, equally familiar with the two, will as positively recognize *Puccinia graminis*, the rust, or, rather, one of the rusts of wheat, as he will *Triticum vulgare*, though the former is very variable for a fungus. The same may be said for *Ustilago maydis*, the smut of corn, and *Zea mays;* but, in this case, there seems to be no variableness nor shadow of turning in the characteristics of the parasite. Hundreds of even better illustrations might be given, all conspiring to enforce the opinion upon the skeptical, that these low, mostly microscopical plants, have specific distinctions as characteristic and rigid as those found among the higher organized, if not more respectable and reputable members of the vegetable kingdom. It is yet to be proved whether or not hybrids ever occur among the fungi; the very fact that none are positively known, or even reported as suspected, helps to indicate the goodness of the species to botanical eyes. Still there is much to be done in the way of experiment, by sowing spores and watching the development of the plants, before much confidence should be placed in the slight distinctions now used in many cases for specific separation.

Passing to our second question, a direct answer cannot be given. In the interdependence and complexity of relations existing among all living organisms, it is exceedingly difficult to pronounce upon the exact effect of any one of them, considered in and of itself. Cold water is not regarded as poisonous to man, yet individuals have severely suffered, even died, from the effects of a reasonable (so far as amount is concerned) draught. Arsenic is poisonous, yet there are those who swallow what would ordinarily be deadly doses, with impunity. Poisonous doses of opium are merely nerve restorers to the habitual eater of the drug. Shall we then say that water causes death when taken to allay thirst, and arsenic and opium are not poisonous? Shall we not rather say that whatever proves seriously injurious to man in a normal condition, under the usual circumstances of his life, is the poisonous thing, and the one which *causes* death; while we assign the peculiar and abnormal condition as the cause in other cases,—as the over-heating instead of the water.

Measured by this standard there are many parasitic fungi which must always be acknowledged as a "cause"

of disease in the higher plants, for they germinate and grow under the usual conditions of our summer weather, and penetrate and develope in and at the expense of otherwise healthy plants. Under these conditions it is only necessary to place the matured spores on the parts of the plants inhabited by the fungus to ensure its growth, and, in consequence, the disease. It is, however, even in these cases, evident that much must depend upon the peculiarities of the weather, etc., whether the host or the parasite is specially favored or repressed, and so whether or not the disease is seriously injurious.

Rust spores on young wheat leaves in spring time are as certain to germinate and penetrate the tissues as arsenic is to poison mammals. In this case development goes on but slowly however, unless specially favorable conditions occur for the parasite, when, in the latter case, it makes its presence easily recognized by the disastrous results too often witnessed. Smut in wheat is less affected by peculiar states of the climate. The spores send their germinal tubes into the tissues of the seedling plants; the fungus grows with the host, and finally, just before harvest time, matures its spores again in the aborted wheat grains. Blight-bacteria, again, need only to be introduced in few numbers into the living bark cells of a healthy pear tree, during ordinary Summer weather, to insure their reproduction and multiplication in myriad numbers, and the death of the invaded cells in consequence of their deleterious action. It is by on means true that plants must be in an enfeebled condition that such parasites may grow upon them. The very vigor of the host often adds, by furnishing more assimilable food, to the extreme development of the parasites.

On the other hand there are many fungi that only grow on the higher plants when these have been injuriously affected by something else, or when the conditions are peculiar and altogether unfavorable for their proper development or growth. Thus apples become "scabby" by a fungus belonging to the preceding class, but they often rot while hanging on the trees through the effects of other fungus never injurious to perfectly sound fruit with an unbroken skin or epidermis. Peaches rot upon the trees under the effect of a mould-like fungus which produces myriads of spores that readily float like dust in a dry atmosphere, but these do not germinate except in moisture, and, as their duration of vitality is very short, few succeed in reproducing the plant except during rainy weather, when one decaying peach may be a source of contagion for hundreds of others. There are too great numbers of leaf-dwelling fungi which only grow upon these organs when from old age or other causes they have lost their powers of existence through the diminution of their vital forces, so that the mycologist learns to look upon old and fading leaves for numerous specimens. In the descending scale we find vast numbers of still other fungi which only grow upon really dead organic matter; these however have no share in the title parasitic.

It may therefore be concluded that, in the struggle for existence, many species of fungi have acquired the physiological power of overcoming the defensive forces of certain higher plants in a state of health under ordinary conditions of plant life and growth, while others, truly parasitic in their nature, are obliged to seize upon favorable chances to take advantage of slight or serious misfortunes happening to their hosts, thus giving the kick to one already going down hill.

I have thus endeavored to point out some of the general truths of vegetable pathology as they appear to one who accounts himself a student but not a master of the subject. I enter the open gateway of a great field, and make little incursions here and there, gathering now and again from the abundance offered, material for many odd hours of microscopical work, which again furnishes "food for thought" when the lamp has been extinguished and the scalpels laid away. There is much room for many better workers, and much interest for those who will work.

CROTON WATER OF NEW YORK.

It is admitted on all sides that an improved supply of water for New York city, both in regard to quantity and quality is imperatively demanded by its citizens, and the subject in one form, will shortly be discussed by the legislature at Albany.

In regard to quantity, the solution appears a simple one, as the present supply is adequate for all legitimate purposes; in fact, if it were not for the great waste of water now practised, the supply would exceed all demands of the present population.

It is claimed by the "*Sanitary Engineer*" that this waste is due to imperfect plumbing, and the facts and figures given, show that such a supposition is, in part, correct. Every householder, however, knows that a wasteful use of the water, due to the whole supply of the city being at the command of every individual, must lie at the root of the evil.

Much printers ink has been wasted in printing proclamations from the authorities to the people, counselling economy in the use of the water, but the time has, perhaps, now arrived when the legislature should decide to employ some remedy and make radical changes in the method of distributing the supply.

The method of running the main supply direct into every house, is certainly the most primitive and least scientific or practical of all means at command. It is an invitation for waste and extravagance, and has proved an utter failure, as the means for thus distributing a supply are so defective that, while one family in a house can draw on the Croton river at will, others, less fortunate, on another level endure a constant water famine.

The whole evil of this imperfect distribution of the water could be remedied, if the supply were made by cisterns only. This system has always been in use in London and answers admirably. Every householder under this system has one or more cisterns filled twice daily, and is not restricted either to the number, capacity or location of the cisterns. Thus each householder pays *pro rata* for the actual amount of water he consumes annually, which, beyond doubt, is the only equitable method of charging a water rate. In the case of manufacturers a meter is substituted, if desired.

A natural accompaniment of this system is a universal high pressure of water throughout the city, which provides that cisterns in the highest part of every house shall receive its supply daily. This mitigates the evil under the present system, of pumping and carrying water above the first and second stories, now necessary in most houses in New York city.

The economy of the cistern system is self evident for no one would call for more water than he could legitimately use and increase the annual water tax. Thus a premium for economy rather than waste is offered. In a sanitary point of view many advantages are attached to the use of cisterns, as the large amount of impurities have time to subside and the water is consumed in an improved condition. It is usual to construct one of the cisterns with slate, which is reserved for drinking purposes.

The plea that such a system curtails the proper use of water has no foundation in fact. The writer lived in a house in London for many years, under this system of supplying water, and found he received not only abundance for family use, but sufficient to water a large garden. If the system here described were put in practice in New York city, and the plumbing perfected, the present supply of water would be found ample, and part of the money now proposed to be wasted in making new storage reservoirs might be profitably used in building pumping stations, which would give a high pressure of water to all the upper rooms in the city, and increase the efficiency of the means now at command for extinguishing fires.

In regard to the quality of the Croton water, we will give an analysis by Professor C. F. Chandler.

CROTON WATER—GRAINS IN U. S. GALLONS. (CHANDLER).

Soda	0.326
Potassa	0.097
Lime	0.988
Magnesia	0.524
Chlorine	0.243
Sulphuric acid	0.322
Silica	0.621
Carbonic acid	2.604
Organic and volatile matter	0.670

Calculating 100,000,000 gallons as the daily average water supply of New York city, the impurities would be as follows:

CROTON WATER. (CHANDLER). IMPURITIES IN 100,000,000 GALLONS.

	TONS.
Soda	2.319
Potassa	0.692
Lime	7.038
Magnesia	3.742
Chlorine	1.735
Sulphuric acid	2.300
Silica	4.429
Carbonic acid	18.600
Organic and volatile matter	4.785

We have the same authority for stating that the organic and volatile matter occasionally reaches 1.14 grains to the U. S. gallon.

It will thus be seen that the constituents of Croton water show it to be excellent as a water supply to a city, being unusually free from mineral matter and having no inorganic substance in excess to make it objectionable.

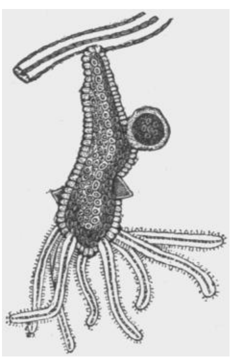


FIG. 2.
Hydra magnified.

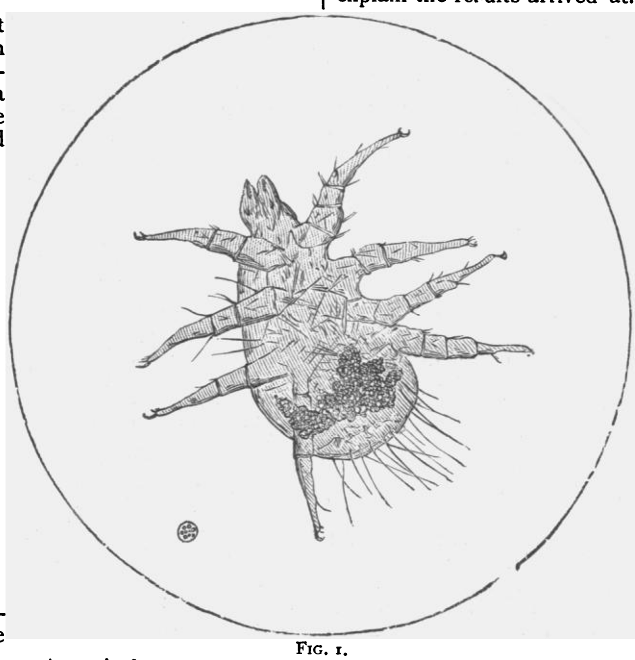


FIG. 1.
A parasite from some, bird or animal and foreign to the water. Seen for two weeks in countless numbers. They were all dead and surrounded by a jelly-like mass of putrescence.—(Michels.)

In discussing, therefore, the quality of Croton water it will be sufficient to confine our attention to the amount of organic matter it contains, and its nature.

To decide this point correctly a comparison of the analyses made by various chemists is desirable, but the greatest difficulties are here met, which are due to the erratic methods of those who have made and recorded these investigations. No two chemists appear to adopt similar methods of making analyses of water, and it is notorious that different methods give quite different results. On the other hand some chemists record their results in United States gallons, some in imperial gallons, and others in parts of 100,000,000, and others in 1,000 gallons.

From necessity rather than choice we will make an average amount of organic matter in Croton water from the following calculations:

	Tons in 100,000,000 gallons.
C. F. Chandler	4.785
E. Waller	18.324
Leeds	27.070
Herald	14.528
Average Tons in each day's supply,	16.176

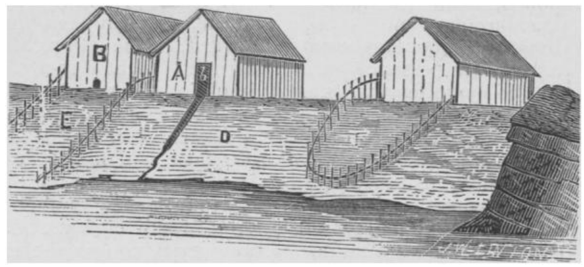


FIG. 4.
Whitlock's Slaughterhouse, showing drainage into Croton water supply.

To determine the nature of this organic and sedimentary matter a microscopical examination is necessary, and, as we have for nearly ten years continuously made such examinations, an attempt will be made to explain the results arrived at.

If a glass of Croton water freshly drawn be held up to the light, it will be noticed, that dispersed throughout the water are very minute particles in countless numbers, which revolve as the water circulates round the glass, while here and there may be noticed (especially during the summer and autumn months), larger pieces having a reddish-brown color. If a piece of sponge is tied over the mouth of a faucet, and the water allowed to run for a short time, the sponge will be loaded in every pore with an accumulation of the impurities in the water. If the sponge is now squeezed in a glass, the water will be found to be opaque on account of the large amount of floating matter, it will emit a foul odor, and the resulting sediment will have the appearence of a foul blackish-brown slime. If a pipette is now used and some

FIG. 3.
Hydræ natural size.

of this deposit placed on a glass slide covered with a thin glass cover, and examined under a microscope, the field will be opaque with the dense nature of the impurities, but if diluted with a little fresh water, objects such as are drawn in figures—and—will be observed. These forms, which will be readily recognizable by microscopists, are composed of unacellular plants, very beautiful in form and mostly of a brilliant emerald green color. A nimallife is also well represented by forms usually found in stagnant ponds, from the purely microscopical forms to those visible with the naked eye; the hydra (figure) with its tentacles ready to grasp as its prey, the little crustaceans which are darting about.

It is no part of this paper to describe these forms specifically, but the sanitary effect of their presence will be referred to in general terms. To prevent any misinterpretation I would state that the forms shown are not seen at a single view, but the contents of the circles represent forms which are all present in the Croton water, and may be seen by making several examinations of the deposit at different seasons. While such forms may be noticed, *the bulk of the deposit* is found to be composed of dead, rotten, and decayed matter (omitted from illustration to make place for more interesting forms) from which the living chlorophil has long disappeared; the larger fragments are of a dirty brown color, in some of which a growth of fungi may be noticed, indicating its antiquity. On an average from six to eight tons or even more of such contaminations mixed with dead, effete matter, is mingled with each day's supply to the city, and when at its worst gives the water that fishy, sickening odor, which in the height of the summer is always present in the Croton water.

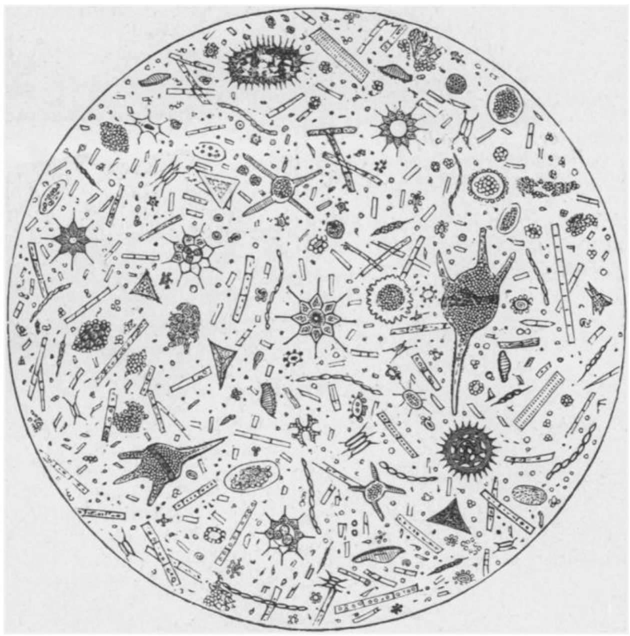


FIG. 5.
Living vegetable forms from the Croton water—(Michels.)

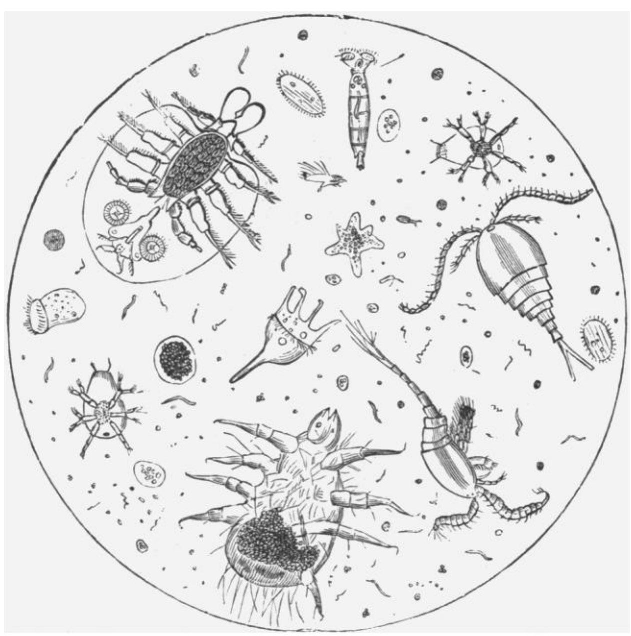


FIG. 6.
Animal organisms found in Croton water.—[Michels.)

With the exception of the eggs of entozoa I consider most the living forms I have noticed in the Croton water to be perfectly harmless in their living state; but they are continually undergoing a process of decay, die, and when dead they are very offensive in their odor, and when present in such numbers as found in Croton water, must contribute to foul the water.

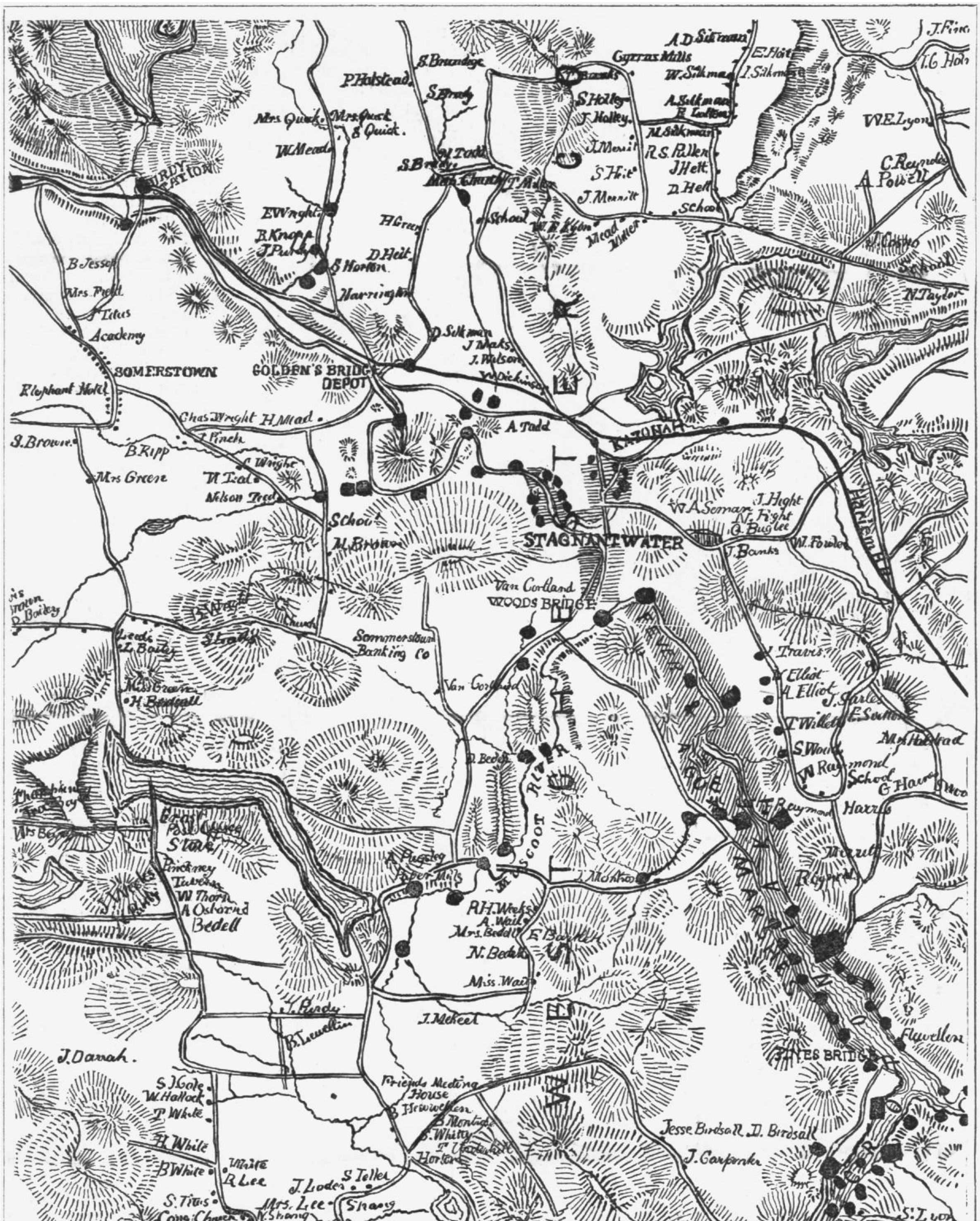
As I have stated, the bulk of the deposit is dead effete matter, forming a stinking slime which is repulsive in its nature, and must be dangerous to use as food. If collected in a spoon no person would swallow such black putrid slime; are therefore the conditions improved or changed when it is thinly dispersed in finely divided particles, so as to make its presence barely visible?

Where does all this filth come from which poisons the water of New York city? In answer to this question, a very brief description of the condition of the Croton water shed will be given, showing the condition of the source of the supply.

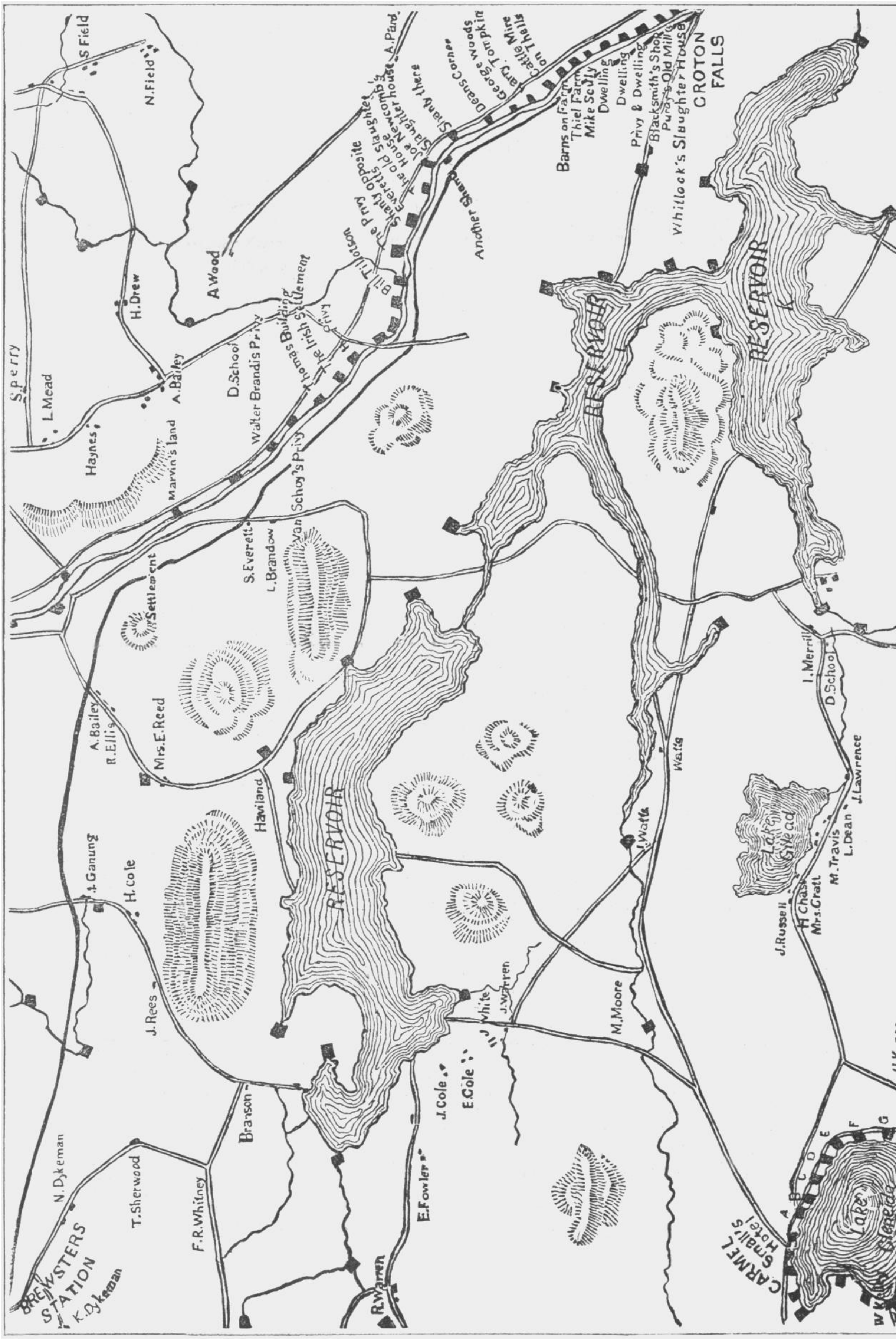
Croton water is the result of collecting the rain fall drained from a large extent of country covering forty miles, which is eventually stored in a series of reservoirs and lakes for future use. The borders of many of these lakes are very shallow and loaded with aquatic plants, and thus brought under the influence of the sun, which destroys the vegetation and converts it into a putrid deposit, which is broken up by the action of the water into fine particles, and eventually delivered at the faucets in our city.

Not long since the Croton lake and the source of the supply up to Croton dam was thoroughly surveyed by Mr. Robert Morris, for the New York *Herald*, whose report was confirmed later by Mr J. Y. Culyer, Engineer, of Prospect Park, Brooklyn, in a letter to the New York *Tribune*, and the *Sun*, *Times*, and *World* have all contributed to expose the state of things we shall now describe.

The report we refer to, states that even Croton Lake wore a green and stagnant look and its shores were sedgegrown, marshy, and laved by little streams that dripped down from barns, houses, hog-pens and farm yards. Various parts were covered with slimy grass, decomposed vegetable matter, and in parts the water was covered with a thick scum. Around other lakes he found stagnant water, fever and ague swamps, filthy drains, wayside sloughs, and on their banks cattle pens and dirty yards. In one place near Mr. Hyde's house, a hollow was found where every kind of rural filth had accumulated and decayed. On pushing his cane into the mass, a stench was stirred up that made him glad to give up further exploration in that direction.



MAP OF CROTON WATER SHED. SOURCE OF IMPURITIES MARKED BY BLACK SPOTS.



Part of Map of Croton Water Shed. Impurities marked by Black Spots.

In another place right across the whole face of the lake stretched half a dozen islands, affording no foothold for man or beast, surrounded by stagnant green water filled with every conceivable vegetable rottenness.

The sewers from farm houses, cottages of laborers and factories were noticed to draindirectly in the water supply; in fact the source of water supply of New York city was found to be a common drain for about 300 cattle yards, dwelling-houses, factories, pig-sties, slaughter-houses, and other sources of impurities, every one of which are distinctly shown on the maps we present, the exact location being indicated by a black spot. Space will not allow us to give futher evidence on this point which it is in our power to offer, but we present a cut of one of these sources of pollution, showing the direct drainage into the Croton water.

Of the danger of drinking such water full of the vilest contaminations we will not dwell, each reader can take his own course, but those who are prudent will both boil and filter it before using for drinking purposes. Individuals and journals still claim that the source of the supply is free from contaminations, and the water pure and fit for drinking purposes; to be consistent they have to say that the water is wholesome.

Professor Leeds of the Stevens Institute recently showed that the Croton water contained more organic volatile mattert han the water supply of Newark, which is taken direct from the Passaic with all the sewage of Paterson and other towns. He found the organic matter in 100,000 parts in New York water to be 6.50, Newark 6.00, Hoboken 4.50. At the February meeting of the American Chemical Society (see page of this number), Dr. E. Waller, of the New York Board of Health, endeavored to deny this startling statement, by producing analyses of his own, showing quite different results. We understand that at the March meeting of the same Society, Professor Leeds asserted to the satisfaction of the Society that Dr. Waller's methods were bad and had led him to error, while the integrity of his own analysis was established.

We consider the method of storing the water supply of a city in shallow, marshy lakes, in fever and malarious districts, to be wrong in principle, and that a radical change in the management of the water supply of New York City, rather than an expensive extension of it, to be the most prudent course to adopt at the present moment.

ELECTRIC CONDUCTION AND DISCHARGE.

By F. E. Upton.

The question of the nature and the vehicle of the electrical discharge is an important one, and its determination will contribute greatly to the solution of many interesting problems in cosmical physics. It is desired in this article to call attention to some recent advances that have been made in this direction.

The view that the phenomenon is one of pure conduction, though it has received the attention of eminent physicists, can be said to be no longer entertained.

When a conductor is made to connect two poles or electrodes which are at a different potential, it is well known that the greater the cross section of the conductor, or in other words, the more of the conducting material is laid bare by a cross section, the *less* resistance will be offered to the union of the electricities of the two terminals, and the greater will be the ensuing current, with a given E. M. F.

Now, in the discharge, the contrary is observed directly. This characteristic of conduction is absent when the discharge takes place; in a tube containing air, the greater the pressure (above a certain inferior limit), or the more of the conducting material there is laid bare by a cross section, the *greater* will be the resistance to the passage of the spark, and the nearer together the terminals will have to be brought to effect a spark with a given difference of potential. Sir Wm. Snow Harris, in 1834, made an attempt to grasp at the law governing the relation of the length of spark to pressure; and he then stated that the length of spark is in the simple inverse ratio of the pressure. Gordon, in 1878, made a series of experiments to test this law, (Elec. and Mag. II. 55-62). He found that from a pressure of about eleven inches to that of the atmosphere, Harris's law held approximately good.

Representing resistance by r, and matter laid bare by cross section by s, in the case of conductor $r = \frac{1}{s}$; in the case of discharge 92 of $r=s$, approximately. Thus there is in question two entirely different order of phenomena.

Another distinctive characteristic of conduction will be recognized in the fact that whenever there is any conductor at all, however small and however long it may be, connecting two poles, some degree of current will flow, as long as there is any difference of potential. With discharge, however, a certain lower limit of distance apart of poles, and of interposed matter, is requisite for any current at all, and when that limit is reached the spark passes, instantaneously, and the discharge commences.

Whether the current passes by conduction or discharge, heat is equally developed; in the conductor in the one case, and in the interposed matter in the other. This common development of heat does not in any way assimilate the two phenomena. The condition of affairs in the two cases will perhaps become obvious if recourse is had to the corresponding hydraulic analogy.

Imagine a pond of water held in place by a dam, with a pipe leading from the bottom of the dam, for the purpose of drawing water from the pond. The smaller that pipe is in section, the smaller will be the current of water flowing through it under a given head, and a certain amount of heat will be developed by friction of the water against the interior of the pipe; moreover some degree of current will flow as long as the pipe has any size of cross section at all. That corresponds to conduction. Now let the pipe be imagined closed to the exit of water; as long as the dam is sufficient, no current at all will flow; but suppose the dam be diminished in thickness gradually and constantly, a point will be eventually reached when it will no longer suffice to hold back the water, which will break through the impediment; the friction of the water against the fragments of the dam, and of those fragments against each other will develop heat as in the first case. That corresponds to the discharge.

By this analogy the difference between conduction and discharge is clearly apparent. A conductor between two points at a different potential never offers any *resistance* to the passage of the current, strictly speaking. Instead of saying that a slender wire offers more resistance than a thick one, it would give a better understanding of the matter to say of the latter that it offered a freer passage to the current than the former. In the case of discharge, on the contrary, the matter interposed between the points acts always as a bar, or resistance to be overcome, and the more there is of it the more resistance. It is never an aid or way.

Mr. E. Goldstein, in the *Annalen der Physik*, describes an ingenious experiment bearing upon this point, which, if not conclusive, is entitled to some consideration. In a discharge tube which was filled with dry nitrogen, he placed a little sodium, which could be vaporized by heating. The positive light had a purplish red color, but in the vicinity of the sodium it was of a golden yellow. By careful heating and manipulation, the upper half of the tube could be kept red and the lower half yellow. Now the tube was brought over and near, in a horizontal and equatorial position, to a powerful magnet. The discharge light was repelled as a slender thread to the opposite (upper) side of the tube; but it was a pure eddish thread, and showed no trace of sodium yellow.

So the sodium was not displaced or repelled under the influence of the magnet, as it would have been had it been a *conductor* of electricity.

There has been considered the possibility that metallic particles thrown off from the electrodes might be the conductors of the current. To determine if this were the case, Mr. Goldstein made use of a tube with platinum electrodes, in which the light from the kathode was deflected by a second kathode. The light alone underwent this deflection, while the minute particles torn off from the platinum, which lodged on the opposite wall of the tube and formed a sort of mirror there, went exactly to the same point after the deflection of the light, as before. There was thus no connection between the light of discharge and the abraded metallic particles.

But the most elegant demonstration in this matter has been furnished by the experiments of De La Rue and Müller: they arranged that the discharge of 2,400 chloride of silver cells should pass through a circuit consisting of a vacuum tube and a large variable resistance, R—; now with different resistances R_1, R_2, the resistance of the vacuum tube formed a varying fraction of the whole resistance; and, according to Ohm's law for the fall of potential along a conductor, the fall of potential along the vacuum tube should have been variable, had its function been that of a conductor. It was found in fact, however, that the fall of potential along the tube remained constant, no matter what resistance was introduced in the remaining part of the circuit between the poles of the battery, showing that the discharge was not a case of true conduction, but that even at the lowest pressure it was disruptive.

THE AMERICAN CHEMICAL SOCIETY.

The February meeting of the American Chemical Society was held on Friday evening, the 3d inst.

Dr. Orazio Lugo was elected a regular member.

The first paper of the evening was "On Crystallized Anhydrous Grape Sugar," by Dr. Arno Behr.

It was customary in the preparation of the anhydrous grape sugar to crystallize it out from an alcoholic solution, particularly from that of methylic alcohol, but Dr. Behr was lead to believe it possible that a simpler method could be devised. After some experimenting, he found that it could be obtained from the ordinary hydrated solution. A solution with 12 to 15 per cent of water gave the best results. In the description of its properties, Dr. Behr stated that when dried in a current of dry air, the crystallized sugar would not retain more than two or three per cent moisture, its reaction was neutral, its melting point is between 141° and 145° C. When tested by the polariscope it showed birotation. Dr. Behr then briefly referred to its economic uses, how by its cheapness it would be largely used by the confectioner, the druggist, and by those who manufacture wines. He also stated that as regards its sweetening qualities, instead of requiring twice as much or more to make it equal to cane sugar, he had found that one and two-thirds as much was sufficient. Mr. Nelson H. Darton followed with a short paper "On the Precipitation of Tannic Acid as Tannate of Copper." This paper was a supplementary description of Mr. Darton's method, already read before the Society. It consists in the precipitation of tannic acid by the ammonia sulphate of copper. The precipitate was tested for ammonia with negative results, and therefore it was contended by Mr. Darton that the precipitate was composed of copper tannate and not the double salt as has been elsewhere claimed.

The final paper of the evening was by Dr. E. Waller, of the School of Mines, Chemist to the New York Board of Health. Its title was "On the Water Supply of New York City. The object of this paper was to contradict certain statements made by Prof. Leeds in his recent paper read before the Society and also published in the *Chemical News*. Dr. Waller produced the analysis made by Dr. Booth in 1843, then by Dr. Chilton running between the years 1843 and 1859, Dr. Chandler's results from analysis in 1869-72, and finally his own, which have been regularly reported since 1872. These latter were represented by means of curved lines on diagrams which showed exactly the amount of each constituent for any time during the past nine years. These we may condense and show by the following table:

	PARTS IN 100,000.		
	Maximum.	Minimum.	Average.
Mineral matter	8.44	3.20	5.702
Org. and vol. matter	4.40	1.67	0.04
Total solids	11.07	4.80	7.38
Hardness	5.40	1.88	3.21
Oxygen by permanganate method	0.383	0.047	0.180

The results obtained by Prof. Leeds in comparison with those showed from the above table were in several instances quite different. Thus, Prof. Leeds finds the total solids to be higher than any result obtained by the New York Board of Health during the past fourteen years. In other determinations similar discrepances were shown by Dr. Waller. The statement that the Croton water was contaminated by tanneries and other factories was objected to as incorrect, the tanning having long since ceased on account of the scarcity of trees. A statement from the Chief Engineer of the Water Department was read, in which he claimed that the water shed of the Croton River was the cleanest of any from which the supply of drinking water was obtained, either in this country or abroad. The population of the country through which the Croton flows does not exceed 20,000 inhabitants, or about one person to every ten acres. In comparison with other cities, the number of inhabitants to the square mile residing along the water shed of Croton, was stated to be extremely small, thus:

	Population to the Square Mile
London	270
Boston	229
Brooklyn	119
Schnectady, Cohoes, West Troy, { Drawing their supply from the Mohawk River. }	103
New York	65
Rochester	36
Albany	77
Poughkeepsie, supply from Hudson River	86

By arguments such as the above, Dr. Waller maintained that the conclusions reached by Professor Leeds were erroneous. In the discussion that followed certain of Dr. Waller's modes of analysis were criticized by Dr. Endemann, but his remarks were merely on a side issue, and had no bearing on the results. M. B.

To the Editor of "SCIENCE."

DEAR SIR:—I am sorry to find that I have been misled as to one important fact stated in my paper upon Standard Time which appeared in "SCIENCE" for January 21st. The Signal Service has not applied for an appropriation of $25,000 for the purpose indicated in the paper, but a bill introduced in the house by Mr. King of Louisiana, asks this amount to enable the *Naval Observatory* to establish and drop time-balls at the principal ports of entry; and this was confounded with the Signal Service bill in the mind of my informant.

I supposed I had good authority for what I wrote, but as the result shows I ought to have looked into the matter more closely before trusting the statement to type. I regret exceedingly to have aided in giving currency to an erroneous statement.

C. A. YOUNG.

PRINCETON.

JUPITER.

BY PROF. G. W. HOUGH, Director Dearborn Observatory.

During the present opposition of Jupiter, the disc exhibits a variety of phenomena of interest to the practical astronomer.

Although this planet has received a good deal of attention during the past century, yet, but few new *facts* have been added, with regard to its physical aspect, since the time of Sir Wm. Herschel.

It appears to be the generally accepted idea that its surface is subject to sudden and extraordinary changes, sometimes accomplished in a few days or even a few hours. New belts are alleged to have been formed or to have disappeared in the course of an hour or two.

We believe conclusions of this kind have been too hastily drawn from the obstructions.

Owing to the rapid rotation of Jupiter, the various spots and markings follow each other so closely that one might readily imagine that what he saw was subject to change under his eye.

The great red spot, which has been an object of so much interest since 1879, becomes visible, in the Chicago telescope, at 2h. 25m. from the meridian of the planet, when its length is about one second of arc. As the rotation carries it further on the disc, it gradually increases in size, until, when on the meridian, it subtends an angle at opposition, of 15 seconds. The smaller spots and markings, of course, become most conspicuous when near the meridian of the disc.

The visibility of objects depend, very much, also, on the condition of the seeing. Sometimes the smaller spots are invisible for weeks, simply because the seeing is not good enough with limited optical power, and not because there has been any radical change on the surface of the planet. Its distance from the earth is another important element in modifying the appearance of phenomena. After conjunction, the great Equatorial Belt and Red Spot are first seen and, as the earth approaches nearer, other markings gradually appear, until the time of opposition, the greatest variety of phenomena is noticeable.

From September, 1879, when micometer measurements were first begun, with the Chicago Refractor, on the markings of the disc, considerable change has taken place in its appearance at different times. But all changes, whether due to the distance of the planet from the earth, variable seeing, or other causes, have been slow and gradual.

The most noticeable change has taken place in belt No. 3 situated 6″ north of the equator. This belt, which was not conspicuous in 1879, gradually increased in width and distinctness in 1880, until at the present time its width is about 2″.5 of arc, and of the same color as the equatorial belt, viz.; reddish brown.

The equatorial region situated between the two outlines of the equatorial belt has been subject to considerable change, but the margins of the belt have not sensibly varied in width or latitude during the past three oppositions.

The great red spot, a conspicuous object even in a small telescope, is alleged to have materially changed in length during 1879, and again in 1880, but numerous micrometer measurements do not confirm this statement.

The following are the mean results, reduced to the mean distance.

	Length. ″	No. of Obs.	Breadth. ″	No. of Obs.	Latitude. ″	No. of Obs.
1879.......	12.25	9	3.46	8	—6.95	8
1880.......	11.55	20	3.54	10	—7.14	12
1881.......	11.50	8	3.49	3	—7.41	7

These numbers indicate a small possible displacement of the center in latitude, but it would be premature to assume such to be the case.

The color of the spot is reddish-brown; however, when the seeing is unusually good, it appears almost a light pink.

The oval-shaped white spots, a number of which were observed in 1880, are quite numerous at the present time. They are about one second of arc in length and are generally difficult objects to observe.

The following spots have been seen on belt No. 6. Latitude 9″. 5 to 12″. 6. They pass the meridian of Jupiter after the great red-spot as follows:

h.	h.	h.	h.	h.	h.	h.	h.
+ 2.8	+ 3.0	+ 3.3	+ 4.0	+ 4.7	+ 5.2	+ 5.5	+5.8

There are also two white spots—more easily seen—near the great red spot in latitude 9″. 63 and longitude 0h. 36m. and +0h. 24m.

The two white spots situated in latitude 3″. 0 south of the equator, which were observed in 1879 and 1880, were first seen this year on July 22. They appear to make a complete revolution around the planet in about forty-five days, corresponding to a rotation period of 9h. 50m. 9 sec.

These spots, which are both occasionally seen at the same time, appear to be fixed relatively to each other.

The difference of longitude was measured with the micrometer as follows:

1880.
July 24, +23.5m.
Nov. 8, +22.6m.
1881.
July 22, +27.5m.
Nov. 26, +27.5m.
Dec. 10, +23.0m.

The fact that they have maintained for a year and a half the same relative position, and at the same time apparently drifted with a velocity of over 260 miles per hour, would seem to disprove the old theory that they are clouds floating in the atmosphere of the planet.

From observations made during the present opposition, it is probable that all the matter between the two margins of the equatorial belt, whether in the form of white spots or dark ones, moves with the same velocity, viz.: a period of 9h. 50m. 9 sec. And it is possible that the belt itself partakes of this motion.

The rotation period of the planet, deduced from our observations on the red spot, made in 1879 and 1880, was 9h. 55m., 33.2 sec. + 0.09 sec. $\sqrt{t}$, in which t is the number of days after Sept. 25, 1879. The observations during 1880 showing that the spot was retrograding with an accelerated velocity.

This formulæ is found to be essentially correct for the present opposition.

The "mean" period for Dec. 14, 1881, comprising an interval of 811 days, being 9h. 55m., 35.80 sec. from observation and 9h. 55m. 35.76 sec. from the formulæ

Assuming the rotation period as above, the centre of the spot has retrograded more than fifty degrees since Sept. 1879, not uniformly, but with an accelerated velocity. It seems difficult to account for this fact on any known hypothesis.

IMPROVEMENTS OF PLANTE AND FAURE'S STORAGE BATTERY.

In a previous number of "SCIENCE" No. 57, July 30th, 1881, we gave excellent directions for making Planté and Faure's storage batteries.—In a recent paper before the "Society of Arts, of London, Professor S. P. Thompson states that almost any oxide or hydrate of lead will answer for use in the Faure battery—Litharge will answer if sufficiently finely divided for being painted on. Litharge mixed with a small proportion of binoxide of manganese works well. The most satisfactory cells I have yet tried were made by painting the lead plates with a coat of the brown peroxide itself, which is obtainable in commerce, although its cost is greater than that of red lead or litharge,